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REPORT
on
PRELIMINARY GEOTECHNICAL INVESTIGATION

PROPOSED COMMERCIAL DEVELOPMENT
17 O'RIORDAN STREET
ALEXANDRIA

Prepared for
GOODMAN PROPERTY SERVICES (AUST) PTY LTD

Project 45586
August 2008

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Douglas Partners Pty Ltd
ABN 75 053 980 117

96 Hermitage Road
West Ryde NSW 2114
Australia

PO Box 472
West Ryde NSW 1685

Phone (02) 9809 0666
Fax (02) 9809 4095
sydney@douglaspartners.com.au

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REPORT ON PRELIMINARY GEOTECHNICAL INVESTIGATION
PROPOSED COMMERCIAL DEVELOPMENT
17 O'RIORDAN STREET, ALEXANDRIA

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1. INTRODUCTION

This report details the results of a preliminary geotechnical investigation undertaken for a proposed commercial development at 17 O'Riordan Street, Alexandria. The work was commissioned by Goodman Property Services (Aust) Pty Ltd, developers of the site.

The project involves the construction of a four storey commercial building over a single level basement. The existing buildings and pavements on the site will be demolished as part of the redevelopment works.

Preliminary geotechnical investigation was undertaken to provide information on subsurface conditions at the site and included cone penetration tests on an adjacent site, engineering interpretation and analysis. Details of the field work and preliminary comments relevant to design and construction are given in this report.

Preliminary contamination assessment was undertaken at the same time as the preliminary geotechnical investigation and is reported separately. Information from boreholes drilled as part of the contamination assessment has also been used for this preliminary geotechnical investigation.

2. SITE DESCRIPTION

The development site is rectangular and approximately 7,360 m^2 in area. It is bounded by vacant land to the north and west, O'Riordan Street to the east and commercial premises to the south. The airport railway tunnel is located near the north-western corner of the site although the invert levels of the tunnel are not known. The ground surface is relatively level and between about RL 11.5 and RL 12 relative to Australian Height Datum (AHD).

At the time of investigation a warehouse building with office and showroom space was located over most of the site. A concrete vehicle parking area and loading dock exists to the north of the building.

3. GEOLOGY AND HYDROGEOLOGY

3.1 Geology

Reference to the *Sydney 1:100 000 Geological Series Sheet* indicates that the site is underlain by Quaternary-aged sediments comprising medium to fine grained marine sands with podsols. Experience in the Alexandria area suggests these sediments are underlain by alluvial sands and clays, residual clay soils and shale or sandstone bedrock.

3.2 Hydrogeology

The *Botany Sand Beds, Botany Basin, NSW Northern, Southern and Western Zones Status Report No.2* (Department of Land and Water Conservation, GWMA018, March 2000) provides an overview of the Botany sand beds. The report indicates that there are two groundwater systems operating in the region, one being a deeper confined aquifer system in the fractured Triassic bedrock and a shallower unconfined to semi-confined system which is present within the unconsolidated sediments of the Botany sand beds. The saturated portion of the Botany sand beds is known as the Botany Sands Aquifer.

The average saturated thickness of the Botany Sands Aquifer is 15 – 20 m. Hydraulic conductivity within the sand beds is highly variable and is typically around 20 m/day in clean sand. This value decreases to 5 – 10 m/day in silty or peaty sands and to less than 4 m/day in sandy peat or clay.

Groundwater flow directions are typically towards the main surface water systems (Alexandra Canal being the closest to the site) with gradients variable but in the order 1 in 120.

Water quality in the Botany Sand Aquifer is typically of low salinity (less than 150 μS/m) and with pH values between about 4 and 9.

4. FIELD WORK

4.1 Methods

The field work included five cone penetration tests (CPTs 1 to 5) undertaken to depths of 12.9 m to 15.5 m on an adjacent site close to the site boundaries. A CPT involves pushing a 35 mm diameter instrumented cone and friction sleeve into the ground using hydraulic thrust from a ballasted truck-mounted testing rig. Measurements of cone resistance and sleeve friction are made at 20 mm depth intervals and are stored on a portable computer. Analysis of this data allows for interpretation of subsurface conditions and properties at a site.

Five boreholes (BHE1 to BHE5) were drilled as part of a preliminary contamination assessment on the site. They were drilled to depths of 1.6 – 6.0 m using a Bobcat-mounted drilling rig fitted with solid flight augers. A groundwater monitoring well was installed in both BHE1 and BHE5 at the completion of drilling.

The ground surface levels at the test locations were measured to AHD using an automatic level, relative to state survey mark SS53812 (RL 11.255). The locations of the CPTs and boreholes are shown in Drawing 1 in Appendix A.

4.2 Results

The subsurface conditions encountered at the test locations are presented in the CPT result sheets and borehole logs in Appendix B. Notes defining descriptive terms and classification methods are also included.

The following strata were encountered or inferred at the test locations and were relatively uniform across site:

- **PAVEMENT/FILLING –** concrete, roadbase, sand and gravel filling with some clay and silt to depths of 2.3 – 3.4 m in the bores.
- **SAND –** sand and silty sand underlying the pavement/filling to depths of 6.4 – 12.9 m. The sand was typically very loose to loose at its surface, grading to medium dense and dense with depth. There were also some looser layers within the dense sand profile.
- **CLAY & SAND –** clay, silty clay, sand and silty sand below the initial sand profile to depths of 8.9 – 14.1 m. The clays were typically stiff and very stiff and the sands medium dense to dense. This stratum is likely to be of alluvial origin.
- **RESIDUAL CLAY –** stiff to hard clay underlying the alluvial materials to the base of the CPTs at 12.9 – 15.5 m depth. There are probably some iron-cemented bands within the residual soil profile.
- **WEATHERED BEDROCK –** it is assumed that cone refusal occurred at or near the top of weathered rock (i.e. at depths of 12.9 – 15.5 m). However, the depth and strength of the bedrock will need to be confirmed by drilling cored boreholes as cone refusal can occur on cemented bands within a soil profile.

Tables 1A and 1B summarise the levels at which different materials were encountered during the field work.

Table 1A – Summary of Test Results from CPTs

Strata	RL of Top of Strata (AHD)				
	CPT1	CPT2	CPT3	CPT4	CPT5
Ground Surface	11.7	11.7	11.9	12.3	12.5
Natural Soil	9.8	8.3	9.4	8.0	8.3
MD or D Sand	7.4	7.6	8.6	7.4	7.7
Alluvial Clays and Sands	5.3	4.6	4.6	4.1	4.1
Residual Clay	2.8	2.2	0.3	-0.6	-1.6
Weathered Rock*	-1.2	-1.8	-1.6	-2.3	-3.0

*Notes: MD = Medium dense; D = Dense; * Inferred from cone refusal*

Table 1B – Summary of Test Results from Boreholes

Strata	RL of Top of Strata (AHD)				
	BHE1	BHE2	BHE3	BHE4	BHE5
Ground Surface	11.8	11.8	11.7	11.7	11.5
Natural Sand	9.5	8.4	8.9	NE	8.4
Base of Bore	5.8	7.8	8.7	10.1	7.0

Notes: NE = Not encountered

It should be noted that in the case of the CPTs, the level of rock should be taken as an estimate only and accurate levels will need to be confirmed by additional investigation.

The groundwater levels in monitoring wells BHE1 and BHE5 were measured on 29 May 2008 following purging of the wells with a disposable bailer. The levels are shown in Table 2.

Table 2 – Summary of Groundwater Levels

	BHE1	BHE5
Ground Surface (AHD)	11.8	11.5
Groundwater Level (AHD)	7.8	7.6
Difference (m)	4.0	3.9

5. GEOTECHNICAL MODEL

The subsurface profile can be described by five main material strata. The pavement and filling on the site is up to 3.4 m deep. The bores indicate that the filling includes sand and gravel with some silt and clay. The concrete pavement in the northern part of the site was observed to be in good condition.

There was generally a very loose to loose silty sand layer beneath the filling then medium dense and dense sand to depths of 6.4 – 8.4 m. Significant layers of soft material were not encountered in this stratum.

The alluvial materials comprised medium dense to dense sands and silty sands and stiff to very stiff clays and silty clays. This layer was about 2.5 – 5 m thick. The alluvium was typically underlain by residual clay soils of stiff to hard consistency. The residual clay soils were generally about 2 – 4 m thick.

Weathered rock is assumed to be at or close to the depth of cone refusal (i.e. 12.9 – 15.5 m). Experience has shown that refusal generally occurs in low strength rock although can occur on stronger cemented bands above the top of bedrock.

Groundwater was encountered between RL 7.6 and RL 7.9 during the field work and between RL 7.6 and RL 7.8 in the monitoring wells 10 days following completion of the drilling. The sand profile is expected to be relatively permeable. A maximum design groundwater level of RL 8.5 is recommended for the site at this stage to take into account expected fluctuations in groundwater levels over time.

This inferred geotechnical model is shown in the cross-sections provided in Drawings 2 and 3 in Appendix A.

6. PROPOSED DEVELOPMENT

The project involves the construction of a four storey commercial building over a single level basement. It is understood that the developer would prefer to keep the basement floor slab above the groundwater table and will therefore need to be above about RL 8.5.

The column loads for the proposed building are not currently known, however based on the size of the structure are expected to be in the order of 3000 – 6000 kN.

The geotechnical issues considered relevant to the proposed development include excavation, excavation support, groundwater and foundations. Preliminary comments on these issues are provided in the following sections as well as discussion on the possible effects on and constraints to the development due to the presence of the nearby railway tunnel.

7. PRELIMINARY COMMENTS

7.1 Excavation

Excavation for the basement levels is expected to be required in filling and sand soils. Excavation in these materials should be readily achievable using conventional earthmoving equipment such as hydraulic excavators with bucket attachments. Excavation in rock will not be required unless rock-socketed piles are used on the site.

It should be noted that any off-site disposal of spoil will generally require assessment for re-use or classification in accordance with current Department of Environment and Climate Change NSW *Waste Classification Guidelines* (April 2008).

7.2 Excavation Support

7.2.1 General

Vertical excavations in filling and sand will not be self-supporting and battering or some form of shoring support will be required. A maximum temporary batter slope of 1.5(H):1(V) is suggested for the filling and sands above the groundwater table where space permits the use of batters.

Temporary shoring by means of steel sheet piles or permanent retaining walls such as contiguous or secant piles can be used to support the basement excavation. These walls could be designed using the parameters shown in Table 3.

Table 3 – Shoring and Retaining Wall Design Parameters

Material	Bulk Unit Weight (kN/m^3)	Coefficient of Active Earth Pressure (K_a)	Coefficient of Passive Earth Pressure (K_p)
Filling	20	0.40	1.5
Medium Dense Sand	20	0.30	2.0
Dense Sand	20	0.25	2.5

Cantilevered walls or walls with a single row of support could be designed using a triangular lateral earth pressure distribution. Walls with more than one row of support should be designed using a rectangular lateral earth pressure distribution in the first instance. Detailed design should ideally be undertaken using a sophisticated software package such as WALLAP or FLAC which can model excavation stages, predict anchor loads and estimate wall movements.

Allowances for surcharge loads from adjacent buildings, pavements, construction machinery, sloping ground surfaces and hydrostatic pressure should also be made in the design of the shoring walls.

7.2.2 Temporary Ground Anchors

Temporary ground anchors may be required on the site to limit wall movements and provide lateral support for the shoring walls until the basement slabs have been constructed. The anchors will probably need to be founded in the sand profile above the alluvial soils.

Sand anchors require the use of specialised contractors experienced in the design and installation of anchors in cohesionless soils. In order to achieve high loads in sands, secondary-grouted or single bore multiple anchor (SBMA) systems will generally be required. Conventional ground anchors and 'duck-bill' type anchors can be installed in sands although experience has shown that these anchors are suitable only for relatively light loads.

The design of specialised sand anchors is best undertaken by an experienced contractor who will often use the results of previous projects and knowledge of their installation equipment to determine an adequate bond length. In any case, a minimum bond length of 3 m is recommended which should be founded behind a line drawn at 45^{o} above the base of the excavation.

7.3 Groundwater

The groundwater levels on the site were measured at RL 7.6 to RL 7.9. For design purposes it could be assumed that the groundwater level may rise to RL 8.5 during significant rainfall and flood events. Basements located above RL 8.5 could be designed as drained basements (i.e. no requirement for tanking).

Detailed advice on tanked basements and dewatering requirements can be provided if the basement will extend below the design groundwater level.

7.4 Foundations

7.4.1 Spread Footings

Spread footings (i.e. strip and pad footings) will not be suitable for the site due to the relatively high column loads and the relatively low strength and relative stiffness of the foundation material at footing level.

7.4.2 Stiffened Raft Slabs

Stiffened raft slabs could possibly be designed to reduce the differential settlement between columns and to spread the building loads over a sufficient area to reduce the applied bearing pressure to acceptable values. Piled raft slabs may also be an option to limit differential settlements.

However, raft slabs would need to be founded in the medium dense to dense sands below the existing filling which is below the groundwater table in some areas of the site. Raft slabs will therefore only be appropriate if dewatering of the basement excavation is proposed. It should be noted that a raft slab may not be appropriate adjacent to the railway easement and at least a portion of the building may need to be founded on piles.

7.4.3 Piles

Piles could be used to support the building loads and could be founded within the weathered rock assumed to underlie the site. Continuous flight auger (CFA) piles would probably be the most suitable pile type for the site. The following parameters could be adopted for the preliminary design and sizing of CFA piles:

- An allowable end-bearing pressure of 2,000 kPa in the low strength weathered rock assumed to exist at cone refusal level;
- An average allowable shaft adhesion of 50 kPa in medium dense to dense sand;
- An average allowable shaft adhesion of 25 kPa in stiff to very stiff clay; and
- An average allowable shaft adhesion of 50 kPa in hard clay.

Settlement of the piles will vary depending on the loads applied and the foundation conditions below the pile toe. As a guide, single piles founded in weathered rock and designed in accordance with this report would be expected to settle less than 5 mm. Differential settlements of 50% of the value of total settlement could be expected between piles. Pile groups would be expected to settle more than single piles and will be dependent on loading, spacing and number of piles in the group.

7.5 Effects of Development on Railway Tunnel

The airport railway tunnel is located near the north-western corner of the development site. The exact depth of the tunnel is not currently known. The basement excavation will be approximately 2.5 m deep at its closest point with the tunnel. Survey information provided by the client indicates that the basement excavation and piling works are expected to be outside both the Zone 1 and Zone 2 areas as defined by RailCorp.

If the development scheme changes so that excavation or construction within the Zone 2 area is proposed then additional analysis of soil stresses and the effects of slabs and piles on the tunnel may need to be undertaken once accurate dimensions are known, preferred footing arrangements have been determined and design footing loads have been estimated. This should ideally be undertaken using a finite difference or finite element software package such as FLAC.

8. FURTHER INVESTIGATION

The current investigation was undertaken to provide an overview of expected subsurface conditions and preliminary design advice to enable planning of the project to proceed. A good portion of the site was inaccessible during the investigation and further investigation incorporating CPTs and diamond-cored boreholes will be required to refine the preliminary advice outlined in this report.

Additional geotechnical input will probably be required to confirm:

- The requirements and design parameters for retaining walls and batters;
- That groundwater is below the proposed depth of excavation;
- Foundation conditions and in particular rock quality below the level of CPT refusal and in areas of the site that were inaccessible during the current investigation;
- Pavement design parameters and expected subgrade conditions across the site; and
- Any other geotechnical issues that become relevant to the project.

DOUGLAS PARTNERS PTY LTD

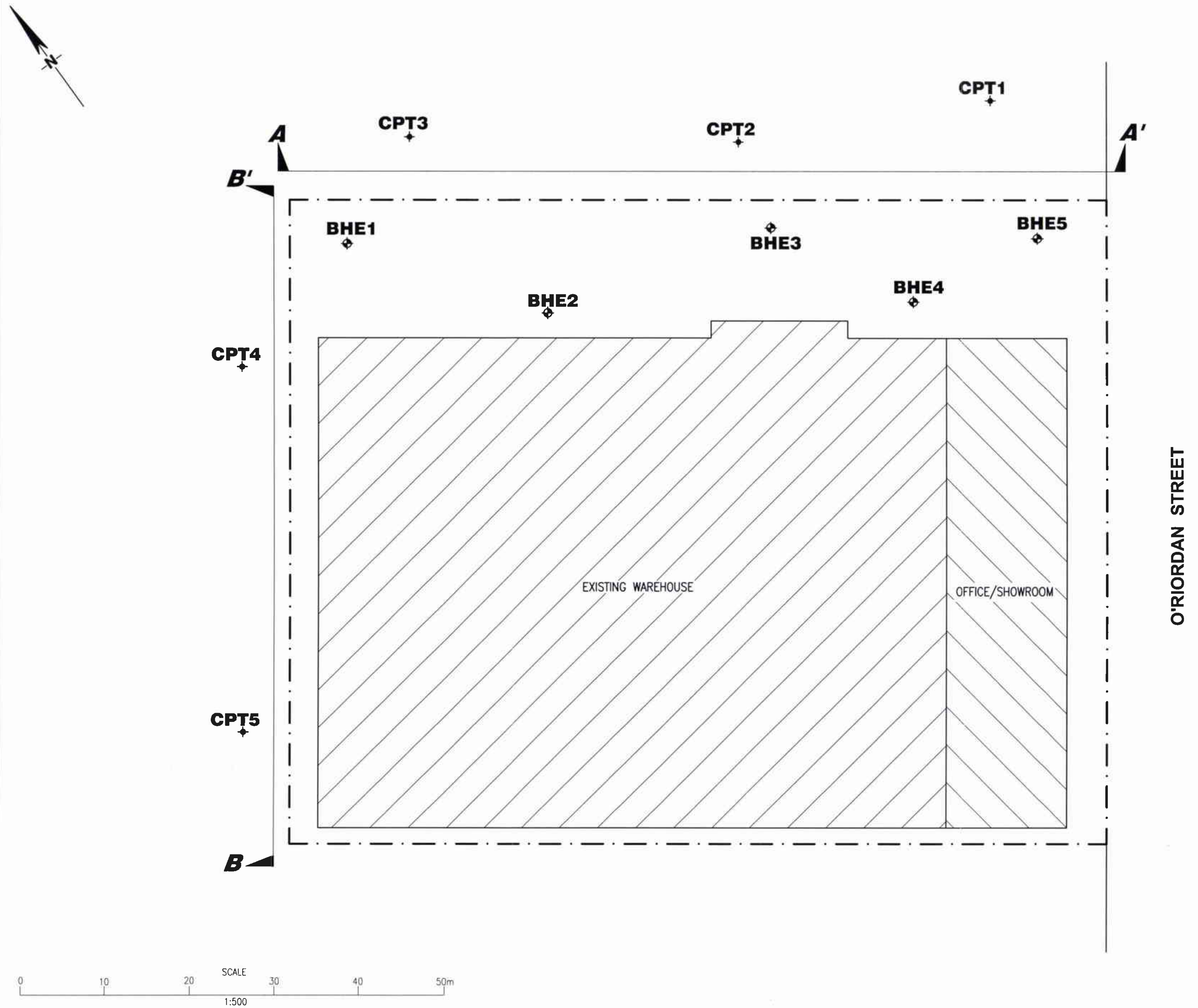
Reviewed by

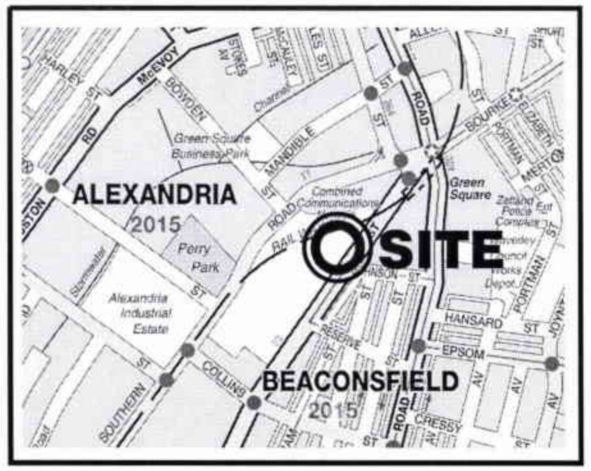
Peter Oitmaa
Associate

Dr T J Wiesner
Principal

APPENDIX A

Drawing 1 – Location of Tests
Drawing 2 – Section A-A’
Drawing 3 – Section B-B’



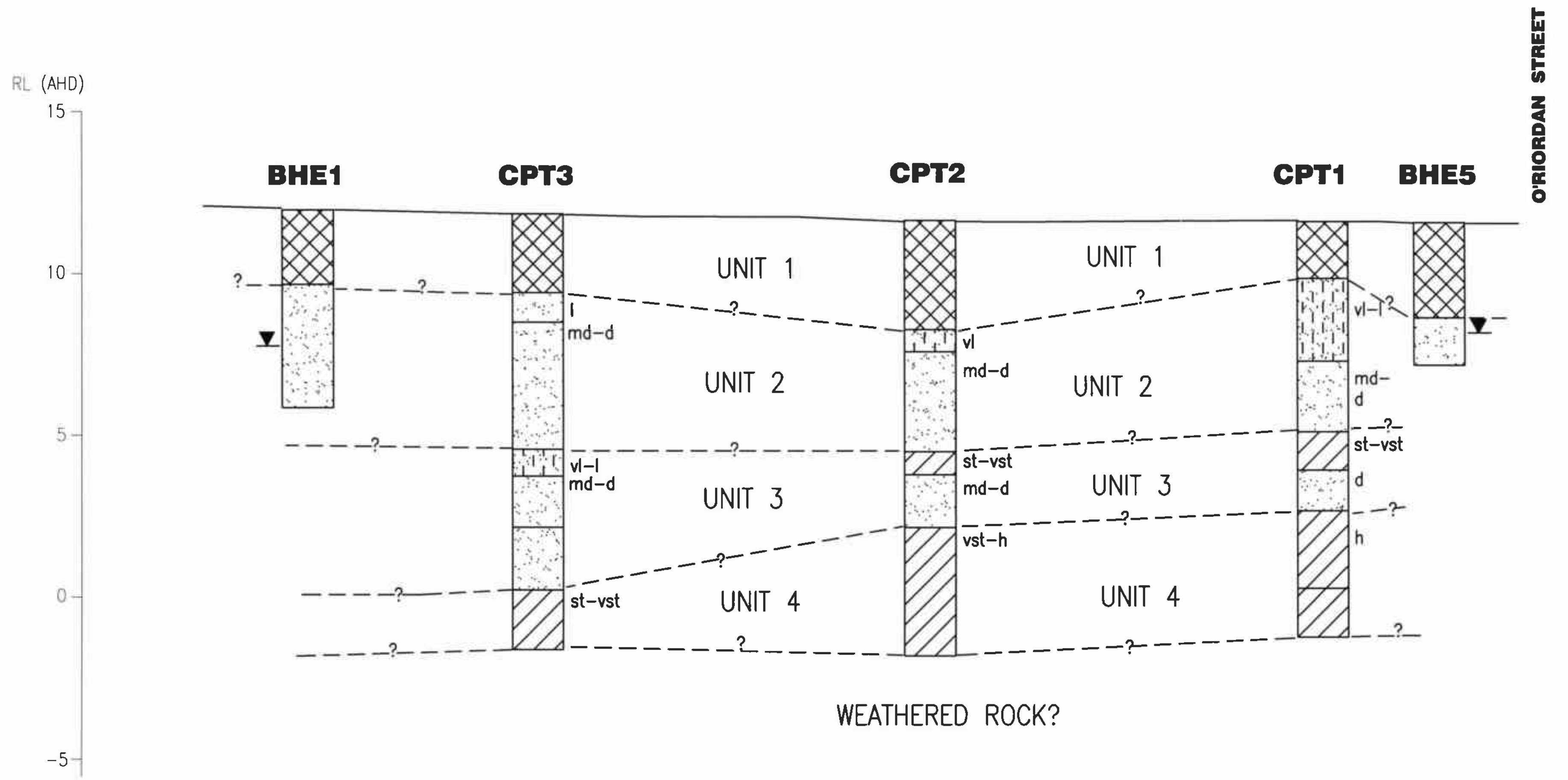


LOCALITY PLAN

LEGEND

- TEST BORE LOCATION
- CONE PENETRATION TEST LOCATION

Douglas Partners Geotechnics · Environment · Groundwater	CLIENT: Goodman Property Services (Aust) Pty Ltd	OFFICE: SYDNEY	TITLE: **Location of Tests Proposed Commercial Development 17 O'Riordan Street ALEXANDRIA**	DRAWING No: 1
	PROJECT No: 45586	DRAWN BY: PSCH		
	DATE: 29.5.2008 SCALE: As shown	APPROVED BY: RW		



LEGEND

FILLING
SILTY CLAY
SAND
CLAY
– –?– – INFERRED STRATA BOUNDARY
▼ GROUNDWATER

SAND
vl VERY LOOSE
l LOOSE
md MEDIUM DENSE
d DENSE

CLAY
st STIFF
vst VERY STIFF
h HARD

NOTE:
UNIT 1 FILLING
UNIT 2 SAND
UNIT 3 ALLUVIAL SAND & CLAY
UNIT 4 RESIDUAL CLAY

SCALE 0 5 10 15 20m 1:200 V

SCALE 0 10 20 30 40 50m 1:500 H

STRATA DEPTHS ONLY ACCURATE AT TEST LOCATIONS
ROCK DEPTHS ESTIMATED FROM CONE REFUSAL

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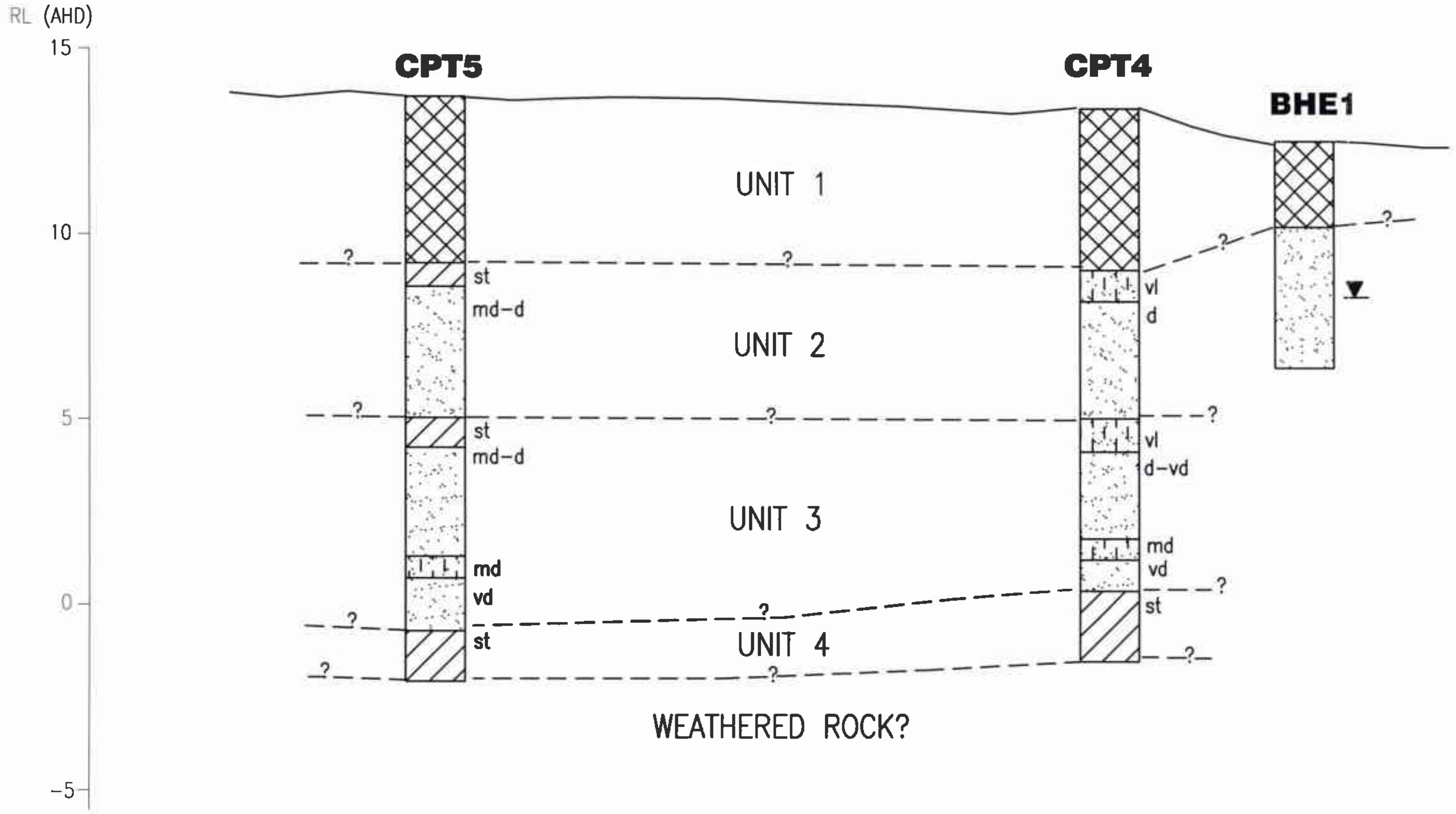
CLIENT: Goodman Property Services (Aust) Pty Ltd		OFFICE: SYDNEY
PROJECT No: 45586		DRAWN BY: PSCH
DATE: 29.5.2008	SCALE: As shown	APPROVED BY: PLW

TITLE: **Section A-A'**
Proposed Commercial Development
17 O'Riordan Street
ALEXANDRIA

DRAWING No: 2



LEGEND

FILLING
SILTY CLAY
SAND
CLAY
INFERRED STRATA BOUNDARY
GROUNDWATER

SAND
vl VERY LOOSE
l LOOSE
md MEDIUM DENSE
d DENSE

CLAY
st STIFF
vst VERY STIFF
h HARD

NOTE:
UNIT 1 FILLING
UNIT 2 SAND
UNIT 3 ALLUVIAL SAND & CLAY
UNIT 4 RESIDUAL CLAY

SCALE 1:200 V (0, 5, 10, 15, 20m)

SCALE 1:500 H (0, 10, 20, 30, 40, 50m)

STRATA DEPTHS ONLY ACCURATE AT TEST LOCATIONS
ROCK DEPTHS ESTIMATED FROM CONE REFUSAL

Douglas Partners *Geotechnics · Environment · Groundwater*	CLIENT: Goodman Property Services (Aust) Pty Ltd	OFFICE: SYDNEY	TITLE: **Section B-B'**
	PROJECT No: 45586	DRAWN BY: PSCH	**Proposed Commercial Development**
	DATE: 29.5.2008 SCALE: As shown	APPROVED BY:	**17 O'Riordan Street ALEXANDRIA**

DRAWING No: 3

APPENDIX B

Notes Relating to this Report
Results of Field Work

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NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigations Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12—25
Firm	25—50
Stiff	50—100
Very stiff	100—200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT “N” Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5—10	2—5
Medium dense	10—30	5—15
Dense	30—50	15—25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing with a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling are given in the report.

Drilling Methods.

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole is advanced using 90—115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" — Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7

  as 4, 6, 7
  N = 13

- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm

  as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0—5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0—50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%—2% are commonly encountered in sands and very soft clays rising to 4%—10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6) \text{ N (blows per 300 mm)}$$

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

$$q_c = (12 \text{ to } 18)\ c_u$$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. Normally, there is a depth limitation of 1.2 m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 “Methods of Testing Soil for Engineering Purposes”. Details of the test procedure used are given on the individual report forms.

Bore Logs

The bore logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than ‘straight line’ variations between the boreholes.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

If these occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document “Guidelines for the Provision of Geotechnical Information in Tender Documents”, published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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Cone Penetrometer Test

The Dutch cone penetrometer test (CPT) is increasing in importance as a means of supplementing or replacing conventional borehole drilling and sampling. These notes describe current techniques and equipment, and illustrate some of the methods of interpretation of test results.

GENERAL PRINCIPLES

The cone penetrometer test, developed initially in Holland, is now standardised throughout the world as a method of site investigation, predominantly used in alluvial soils.

The test utilises a 35mm dia. cone with a following friction sleeve which is pushed into the soil by hydraulic thrust. Push rods, of the same diameter, are added at 1m intervals and penetration to depths of 30 - 50m can be achieved if conditions are suitable.

Measurements are made of the resistance to penetration of both the cone and the friction sleeve and are expressed in terms of end bearing pressure on the cone and average shaft friction on the sleeve (in MPa and kPa, respectively). The ratio between the frictional resistance and the cone resistance (friction ratio) is generally low in sands and high in clays, thus providing an interpretive method of determining soil stratification. The cone resistance value provides a continuous measure of soil strength or density.

The test procedure is covered by Australian Standard AS 1289 ("Testing Soils for Engineering Purposes") — Section F5.

METHOD OF OPERATION

Up until the early 80's, "mechanical" equipment was used, with central push rods to actuate the cone, with forces and measured by pressure gauges in surface mounted hydraulic cylinders.

Today's equipment utilises electronic methods with:

- strain gauges in the cone and friction sleeve, connected by wiring through the push rods to the surface
- a site monitor and computer to capture the data — results are displayed on a screen
- replay of results on an office plotter
- an inclinometer in the cone to measure deviations from vertical.

Testing is preferably carried out from a purpose designed ballasted truck-mounted unit, with sufficient thrust capacity to ensure penetration of dense layers. A unit with about 15 tonnes thrust is normally adequate for most situations.

Testing may also be carried out from the feed system of drill rigs, but unless special anchoring is undertaken, the available thrust capacity of 2 - 3 tonnes is not sufficient to penetrate dense sand layers or extensive zones of stiff clays.

The 35mm cone and friction sleeve are attached to push rods of the same diameter and pushed into the soil by a hydraulic ram. New rods, through which the electrical data cable has been pre-threaded, are added after each 1m of penetration. The rate of penetration is set at 20mm/second and strain gauge signals are sampled by the surface monitor at 20mm intervals. Digital results for cone resistance, shaft adhesion and friction ratio are displayed on the screen of the on-site computer and on completion of each test, the operator can view a graph of the results. These are stored on a floppy disk for later office replay on a plotter.

ADVANTAGES AND APPLICATIONS

Advantages of the cone penetrometer test in engineering site investigations are:

- reliable information, not subject to operator techniques and with minimal need for on-site supervision
- continuous (rather than intermittent) measure of density or strength
- extensive data available from previous experience for analysis and interpretation of results
- immediate charting of results
- high output — 80 to 120m per day
- low cost technique, less than alternative borehole drilling, sampling and in-situ testing
- accurate measurement of stratification depths and recording of thin layers, often missed in borehole investigations.

The test system is most suited for alluvial soils and depths of up to 30 - 50m are possible, depending on ground conditions.

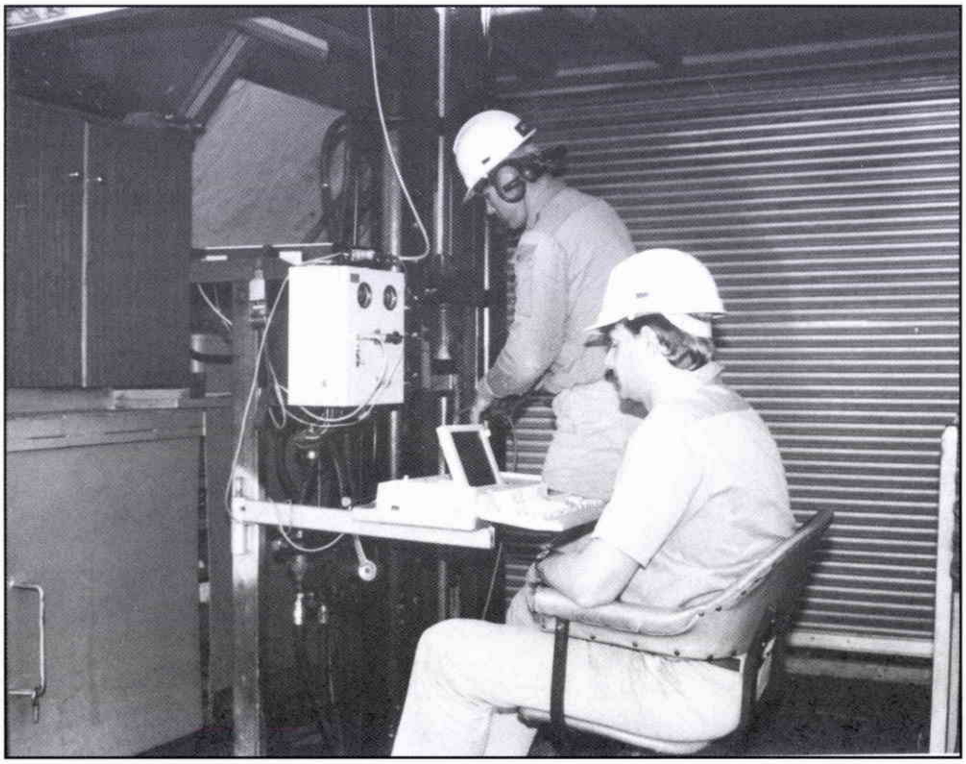
The test is not suitable in very gravelly soils or residual soils which may contain fragments or weak rock zones which impede or deflect the cone.

On sites containing rubble or rock filling, initial assistance may be required from a drilling rig to penetrate the surface.

The information obtained from the test can be used for design of shallow foundations, pile systems and retaining structures and the estimation of settlements of compressible soils.

CONDUCTIVITY MEASUREMENTS FOR GROUNDWATER

Cone technology can be used also in groundwater investigations. The conductivity cone can measure variations in soil conductivity with depth, making it an ideal tool in the investigation of saline groundwater or pollutant plumes.



COMPANY FACILITIES

Company inhouse facilities for cone penetrometer testing include:

- cones and monitor units with automatic capture of results
- incorporation of an inclinometer in the cones to ensure verticality
- truck-mounted, ballasted, custom-designed deployment units attached to Sydney and Brisbane offices
- trailer mounted rig and light hand operated equipment for confined areas
- heavy-duty drilling rig with a separate jacking frame in the centre of the unit to allow high capacity testing
- conductivity cone for groundwater investigations.

These facilities are continually being upgraded to keep abreast of technology improvements.

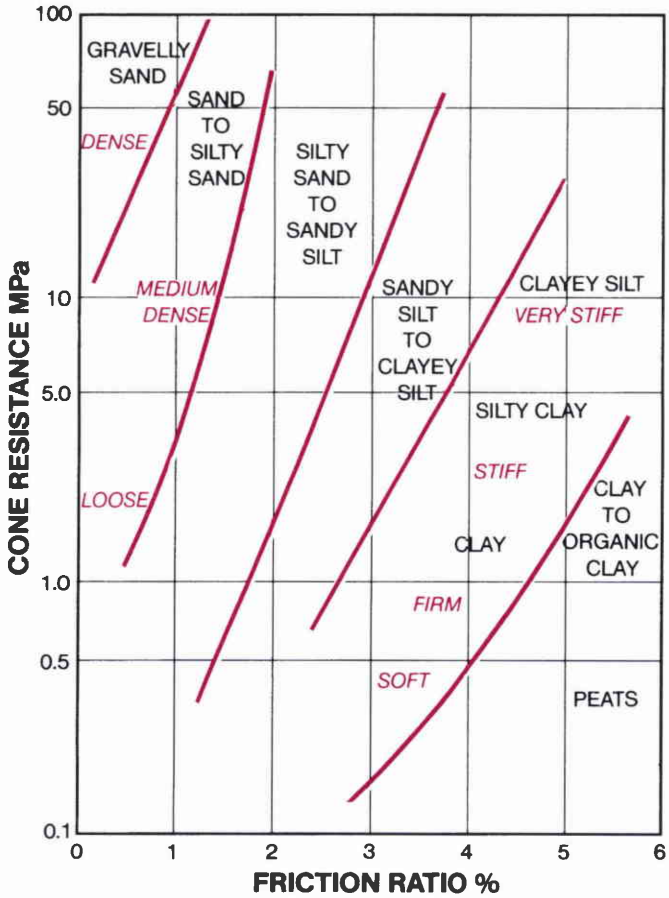
INTERPRETATION OF RESULTS

A great deal of research and investigation has been carried out to correlate the results of CPT's with other physical soil properties.

DETERMINATION OF SOIL TYPE

The ratio of sleeve friction to cone resistance (friction ratio — expressed as %) is used as an indication of the soil type being probed. In sands, friction ratios are generally low and of the order of 1 - 2%. In clays (with much higher shaft friction), the ratio may range up to 6 - 8%.

A chart which allows assessment of soil type is given below:



With the above, the cone-friction sleeve results allow an accurate assessment of layer thickness (stratigraphy) within a profile. The test method will provide a very much more accurate delineation of layers than is possible with conventional drilling and sampling, where information is only obtained intermittently. The cone test will frequently pick up thin layers which may be unnoticed in a conventional borehole investigation.

DETERMINATION OF SOIL STRENGTH

Soil strength is usually determined from the cone resistance values. The normally accepted relationship for clays, linking undrained shear strength with cone resistance is:

$$c_u = (q_c - \sigma)/k$$

where q_c = cone resistance
c_u = undrained cohesion
σ = effective stress
k = 12 - 15

For sands, there are a number of methods of linking cone resistance values with friction angle (ϕ). Interpretation must normally take into account the overburden pressure, but as a guide, for a depth of around 5m, the following is an approximate correlation:

q_c (MPa)	1	4	12	30
ϕ (degrees)	28	32	36	40

CORRELATION WITH SPT VALUES

There have been many measurements to correlate standard penetration test values with CPT's. For medium to coarse sands, the correlation is:

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6)N \text{ (blows per 300mm)}$$

For fine sands, the multiplier is 0.3 to 0.45.

MODULUS AND DEFORMATION VALUES

Published correlations linking cone resistance and modulus or compressibility values indicate a relatively wide range of values. This is probably due to inherent soil variability, time effects and the fact that modulus in any case is not uniquely dependent on strength or density.

For clays, the published correlations are mainly in the range $E = (3 \text{ to } 7)q_c$ (E = Young's modulus). Values of the multiplier of around 3 - 5 are probably most appropriate for soft, normally consolidated clays, with values of 5 - 7 for stiffer and slightly over-consolidated clays. Values in excess of 10 may be appropriate for heavily over-consolidated or residual clays.

For sands, published correlations are mainly in the range $E = (1.5 \text{ to } 5)q_c$, with values towards the upper end of the range being appropriate in most circumstances.

FOUNDATION DESIGN

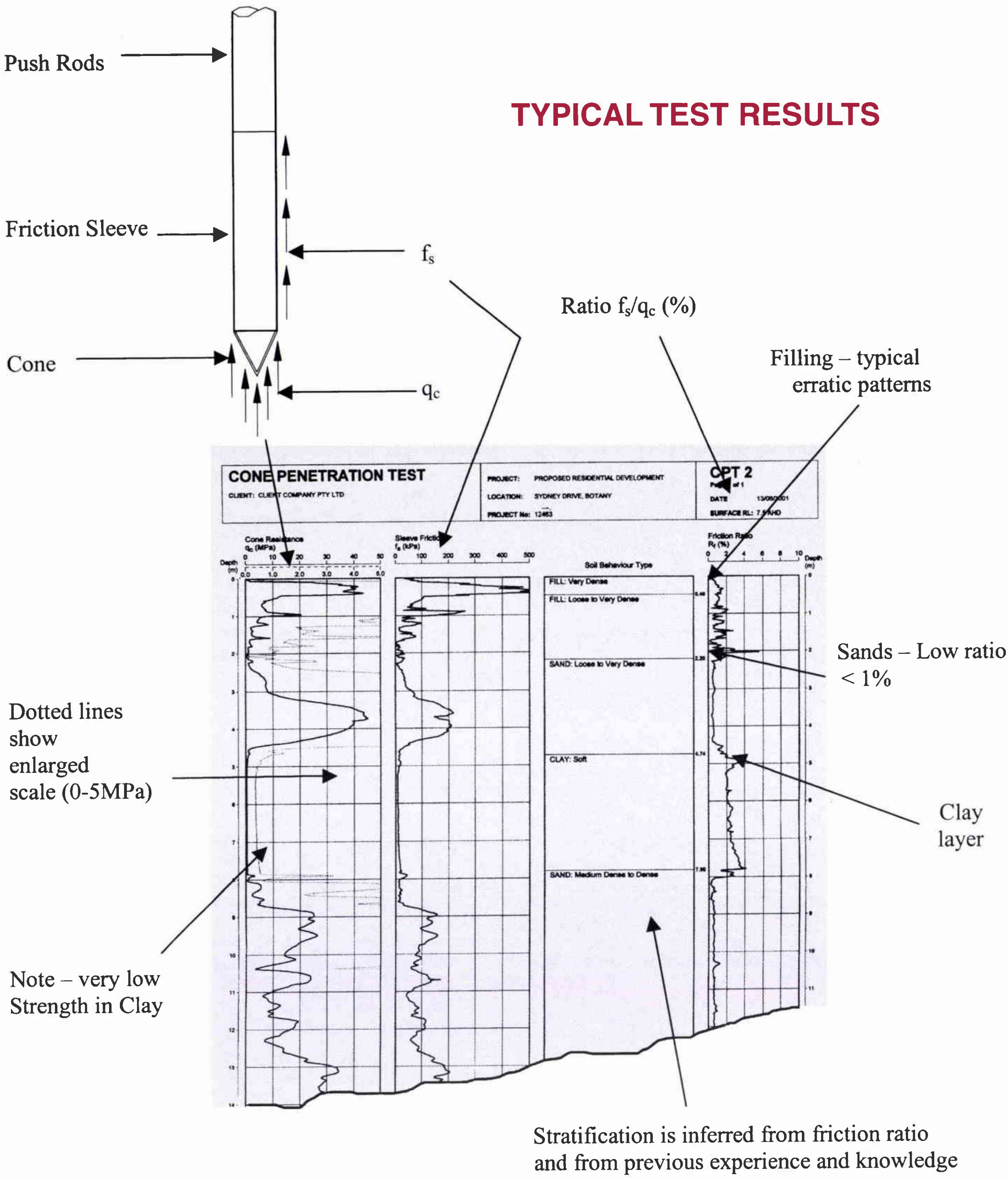
A number of methods are available which utilise cone results directly for the design of both shallow and deep foundations.

The cone is often considered as a model "pile" and for pile design, corrections are needed for the scale effect and the fact that static rather than "quasi static" bearing capacity is measured. More detailed information is given in the references.

REFERENCES

1. Standards Association of Australia, "Methods of Testing Soil for Engineering Purposes" AS 1289 F.15. — 1977 — Determination of the Static Cone Penetration Resistance of a Soil — Field Test Using a Cone or a Friction Cone Penetrometer.
2. SANGLERAT, G. "The Penetrometer and Soil Exploration", Developments in Geotechnical Engineering, 1, Elsevier 1972.
3. MEYERHOF, G.G. General Report — "Outside Europe" Proceedings of the European Sym. on Penetration Testing, ESOPT, Stockholm, June 5 - 7 1974 Vol. 2:1.
4. VARIOUS — "Design Parameters in Geotechnical Engineering" VII European Conference on Soil Mechanics and Foundation Engineering Brighton 1979 Vol. 1-4.
5. MITCHELL, J.K., LUNNE, T.A., "Cone Resistance as Measure of Sand Strength", ASCE Jnl. of Geotech. Engineering Division, July 1978.
6. SCHMERTMANN, J.H. "Static Cone to Compute Static Settlement on Sand" Proc. ASCE Jnl. Soil Mech. and Found. Div. 1970.
7. ISOPT 1, "Proceedings of First International Conference on Penetration Testing", Florida 1988, Balkema.

TYPICAL TEST RESULTS



CONE PENETRATION TEST

CLIENT: GOODMAN PROPERTY SERVICES (AUST) PTY LTD

PROJECT: PRELIMINARY GEOTECHNICAL INVESTIGATION

LOCATION: 17 O'RIORDAN ST, ALEXANDRIA

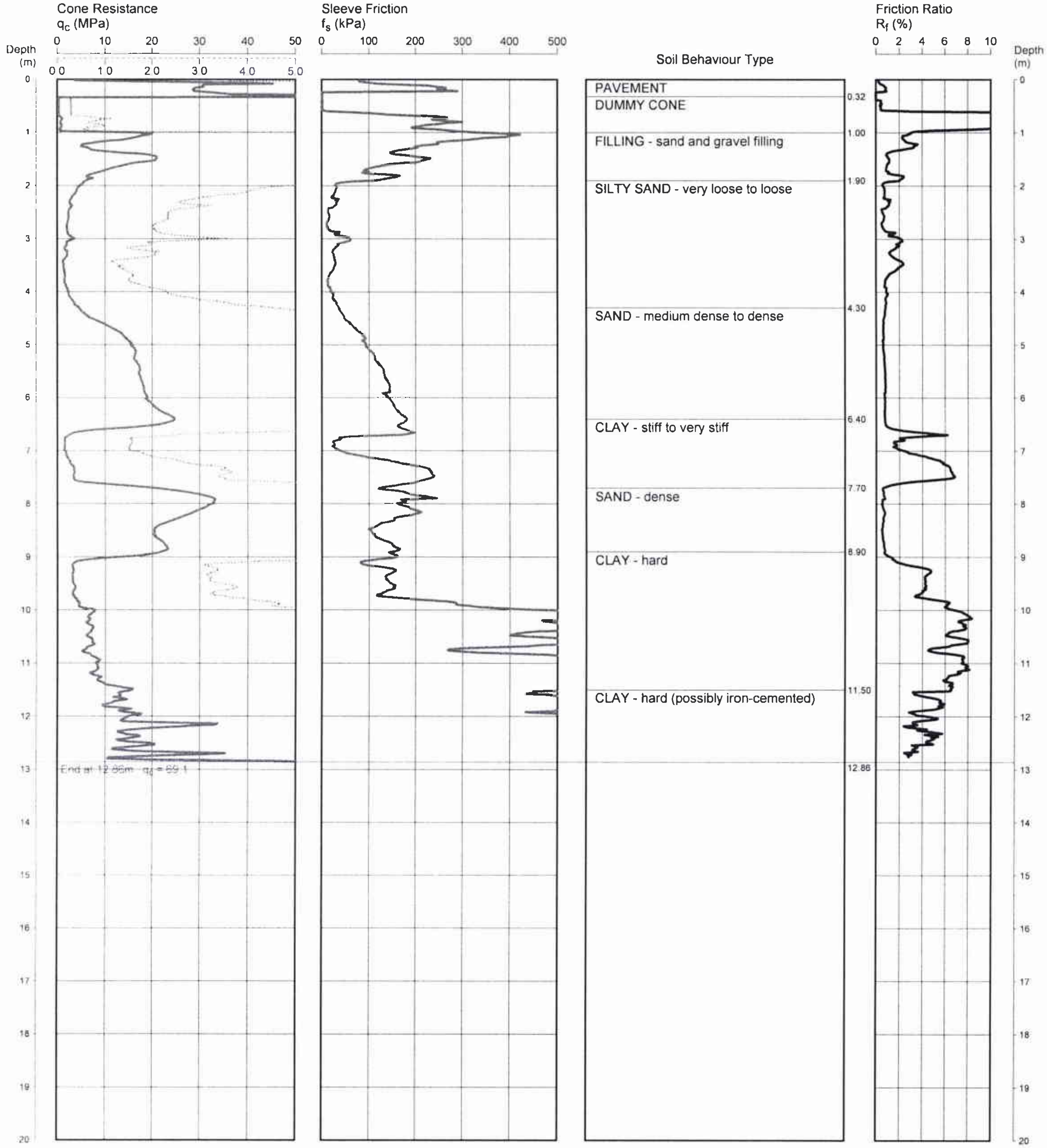
PROJECT No: 45586

CPT 1

Page 1 of 1

DATE 10/05/2008

SURFACE RL: 11 7



REMARKS: HOLE COLLAPSED AT 3 65 m AFTER WITHDRAWAL OF RODS
DUMMY CONE USED FROM 0 32 - 1 0 m

Date	30.5.08
Plotted	
Checked	RLB

File: P \45586 ALEXANDRIA, 17 O'Riordan Street Preliminary Inv PMO\Field\CPT DATA\45 1
Cone ID: CONE-HH1 **Type:** 2 Standard

ConePlot Version 5 8 1

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CONE PENETRATION TEST

CLIENT: GOODMAN PROPERTY SERVICES (AUST) PTY LTD

PROJECT: PRELIMINARY GEOTECHNICAL INVESTIGATION

LOCATION: 17 O'RIORDAN ST, ALEXANDRIA

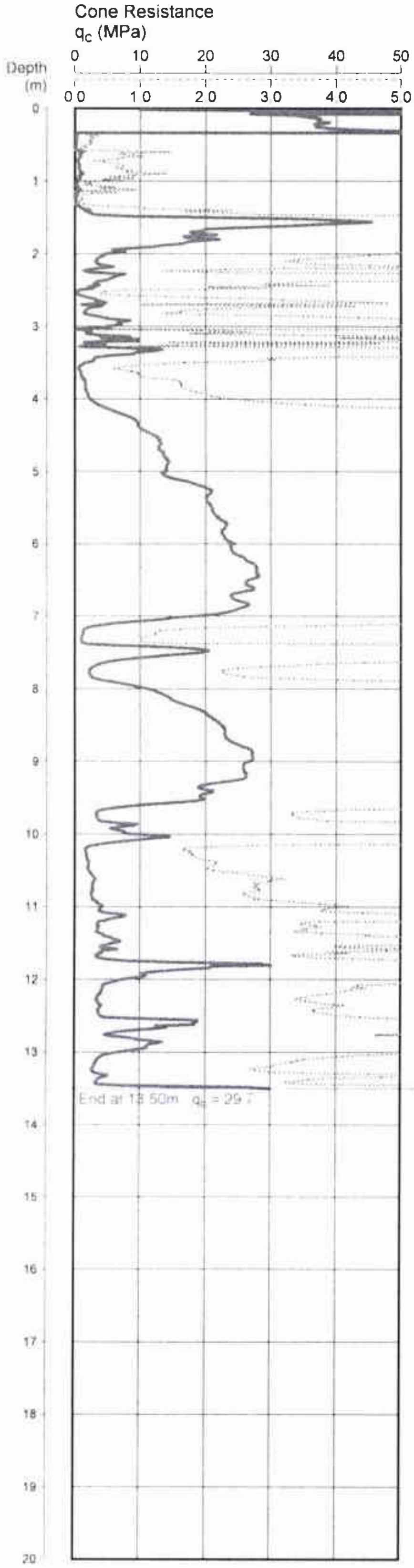
PROJECT No: 45586

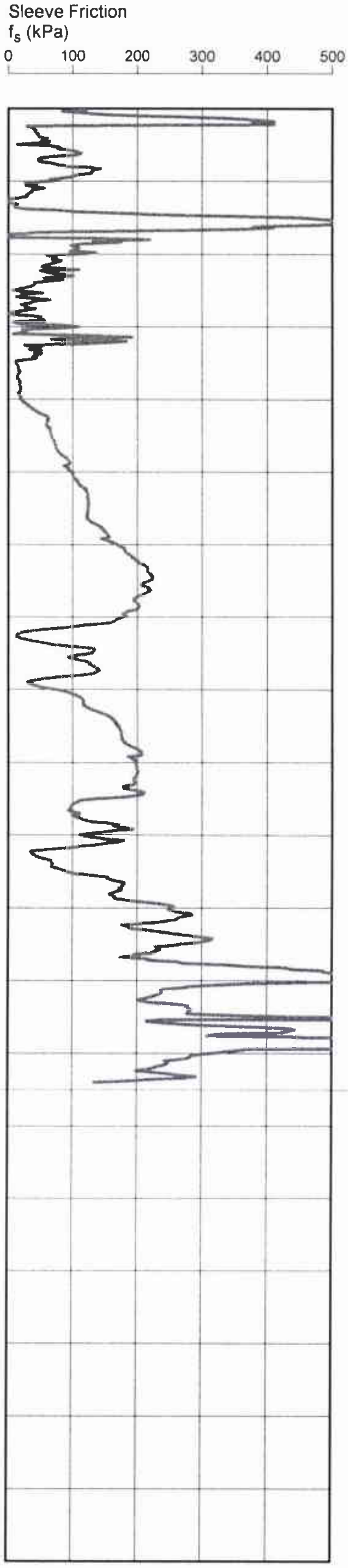
CPT 2

Page 1 of 1

DATE 10/05/2008

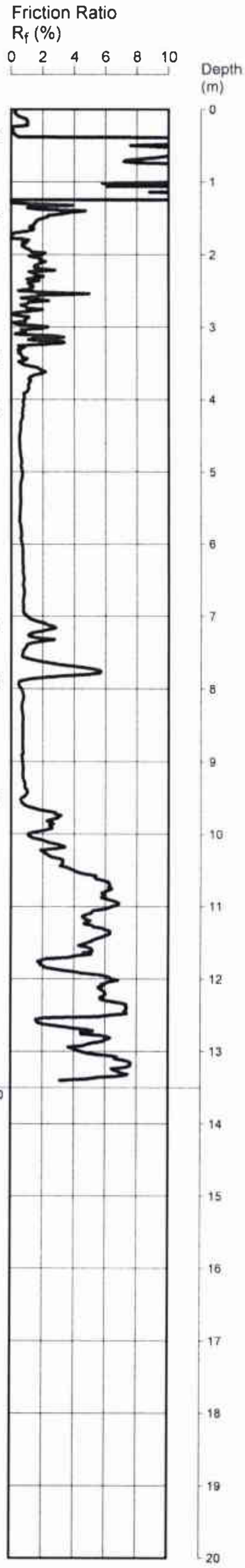
SURFACE RL: 11.7





Soil Behaviour Type

Depth (m)	Soil Behaviour Type
0 – 0.32	PAVEMENT
0.32 – 1.48	DUMMY CONE
1.48 – 3.40	FILLING - sand and gravel filling
3.40 – 4.10	SILTY SAND - very loose
4.10 – 7.10	SAND - medium dense to dense
7.10 – 7.90	SILTY CLAY - stiff to very stiff
7.90 – 9.50	SAND - medium dense to dense
9.50 – 13.50	CLAY - very stiff to hard (possibly with iron-cemented bands)



REMARKS: HOLE COLLAPSED AT 2.8 m AFTER WITHDRAWAL OF RODS
DUMMY CONE USED FROM 0.32 - 1.48 m

Date 30.5.08
Plotted
Checked RLO

File: P:\45586 ALEXANDRIA, 17 O'Riordan Street Preliminary Inv PMO\Field\CPT DATA\45 2
Cone ID: CONE-HH1 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: GOODMAN PROPERTY SERVICES (AUST) PTY LTD

PROJECT: PRELIMINARY GEOTECHNICAL INVESTIGATION

LOCATION: 17 O'RIORDAN ST, ALEXANDRIA

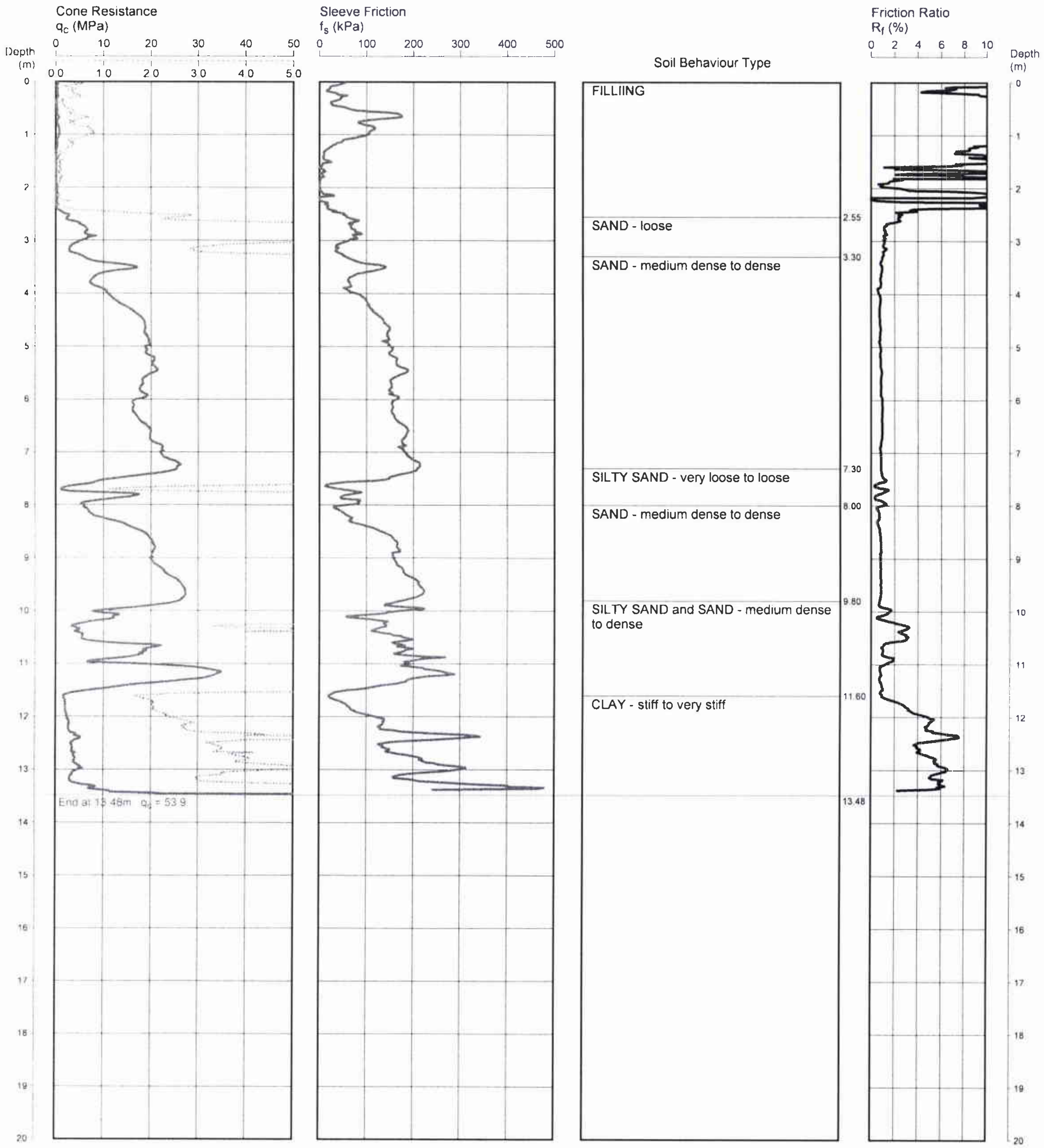
PROJECT No: 45586

CPT 3

Page 1 of 1

DATE 10/05/2008

SURFACE RL: 11.9



REMARKS: HOLE COLLAPSED AT 3.3 m AFTER WITHDRAWAL OF RODS
DUMMY CONE USED FROM SURFACE TO 2.55 m

Date	30.5.08
Plotted	
Checked	ALD

File: P:\45586 ALEXANDRIA, 17 O'Riordan Street Preliminary Inv PMO\Field\CPT DATA\45 D
Cone ID: CONE-HH1 **Type:** 2 Standard

ConePlot Version 5.8.1

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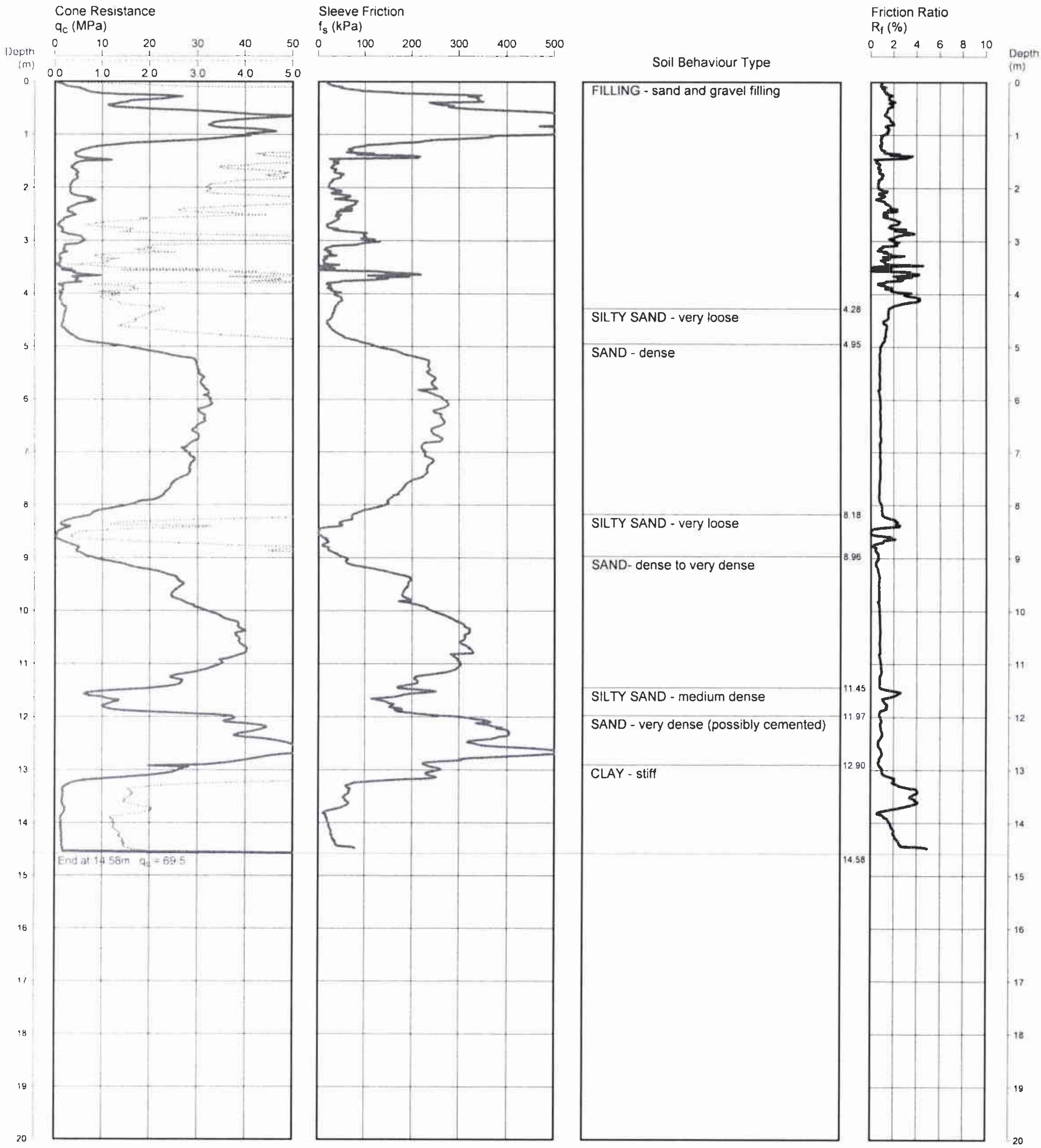
CONE PENETRATION TEST

CLIENT: GOODMAN PROPERTY SERVICES (AUST) PTY LTD

PROJECT:	PRELIMINARY GEOTECHNICAL INVESTIGATION	**CPT 4**	
		Page 1 of 1	
LOCATION:	17 O'RIORDAN ST, ALEXANDRIA	**DATE**	10/05/2008
PROJECT No:	45586	**SURFACE RL:**	12.3



REMARKS: HOLE COLLAPSED AT 2.9 m AFTER WITHDRAWAL OF RODS

Date 30-5-08
Plotted
Checked PWO

File: P:\45586 ALEXANDRIA, 17 O'Riordan Street Preliminary Inv PMO\Field\CPT DATA\45
Cone ID: CONE-HH1 **Type:** 2 Standard

ConePlot Version 5.8.1

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CONE PENETRATION TEST

CLIENT: GOODMAN PROPERTY SERVICES (AUST) PTY LTD

PROJECT: PRELIMINARY GEOTECHNICAL INVESTIGATION

LOCATION: 17 O'RIORDAN ST ALEXANDRIA

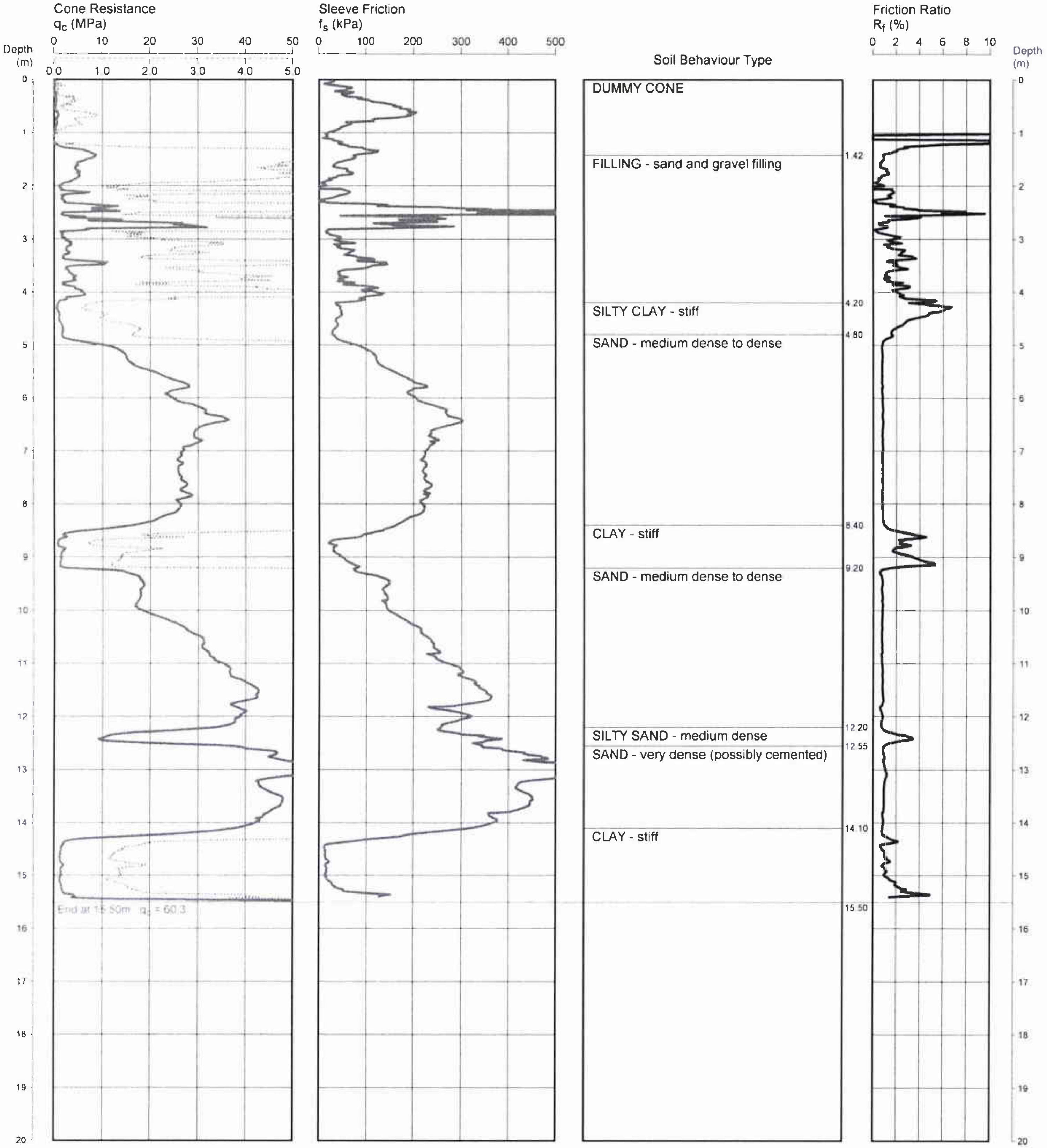
PROJECT No: 45586

CPT 5

Page 1 of 1

DATE 10/05/2008

SURFACE RL: 12 5



REMARKS: HOLE COLLAPSED AT 2 6 m AFTER WITHDRAWAL OF RODS
DUMMY CONE USED FROM SURFACE TO 1 42 m

Date 30-5-08
Plotted
Checked RLC

File: P \45586 ALEXANDRIA, 17 O'Riordan Street Preliminary Inv PMO\Field\CPT DATA\45[illegible]B
Cone ID: CONE-HH1 **Type:** 2 Standard

ConePlot Version 5 8 1

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BOREHOLE LOG

CLIENT:	Goodman Property Services (Aust) Pty Ltd	**SURFACE LEVEL:** 11.8 AHD	**BORE No:** E1
PROJECT:	Preliminary Contamination Assessment	**EASTING:**	**PROJECT No:** 45586
LOCATION:	17 O'Riordan Street, Alexandria	**NORTHING:**	**DATE:** 19 May 08
		DIP/AZIMUTH: 90°/--	**SHEET** 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Sample	Results & Comments	Water	Well Construction Details
0.12	CONCRETE - with 8mm diameter reinforcement	E	0.2				Flush Gatic Cover; Concrete plug
0.7	FILLING - brown, slightly gravelly, sand filling with a trace of silt, humid	E	0.5				Sand backfill
2.3	FILLING - grey and brown, sand filling with some gravel, humid	E*	1.0				Bentonite Pellet Plug
		E	1.5				
		E	2.0				Backfilled with gravel
2.7	SAND - orange brown and grey, medium grained sand with some clay, humid	E	2.5				
4.2	SAND - orange brown and grey, medium grained sand with a trace of silt, humid	E	3.0				Machine slotted PVC screen
5.0	SAND - dark brown, slightly silty, fine to medium grained sand, moist	E	4.5			Water level at 4.2	End cap
6.0	SAND - yellow brown, medium grained sand with a trace of silt, moist to wet						
	Bore discontinued at 6.0m						

RIG: Bobcat **DRILLER:** Gregor **LOGGED:** Mikhail **CASING:** Uncased

TYPE OF BORING: 100mm diameter solid flight auger with TC-bit to 6.0m

WATER OBSERVATIONS: Free groundwater observed at 4.2m

REMARKS: E = Environmental sample; * Field Replicate FR1 collected at 1.0m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep; Water level

CHECKED
Initials: RCO
Date: 30-5-08

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BOREHOLE LOG

CLIENT: Goodman Property Services (Aust) Pty Ltd
PROJECT: Preliminary Contamination Assessment
LOCATION: 17 O'Riordan Street, Alexandria

SURFACE LEVEL: 11.8 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: E2
PROJECT No: 45586
DATE: 19 May 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.16	CONCRETE - with 8mm diameter reinforcement		E*	0.2				
11		FILLING - brown and grey sand filling, with some gravel and a trace of clay, humid to damp		E	0.5				
	1			E	1.0				
10	1.3	FILLING - brown and grey, sand filling with a trace of silt and gravel, humid to damp		E	1.5				
	2			E	2.0				
9	2.3	FILLING - brown sand filling with some clay and gravel, damp		E*	2.5				
	3			E	3.0				
8	3.4	SAND - brown medium grained sand with a trace of silt, damp to moist		E	3.5				
	4.0	Bore discontinued at 4.0m							

RIG: Bobcat **DRILLER:** Gregor **LOGGED:** Mikhail **CASING:** Uncased

TYPE OF BORING: 100mm diameter solid flight auger with TC-bit to 4.0m

WATER OBSERVATIONS: No free groundwater observed

REMARKS: E = Environmental Sample;
*Field Replicate FR2 collected from 0.2m; *Field Replicate FR3 from 2.5m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⊽ Water level

CHECKED
Initials: RW
Date: 30-5-08

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BOREHOLE LOG

CLIENT: Goodman Property Services (Aust) Pty Ltd
PROJECT: Preliminary Contamination Assessment
LOCATION: 17 O'Riordan Street, Alexandria

SURFACE LEVEL: 11.7 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: E3
PROJECT No: 45586
DATE: 19 May 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.16	CONCRETE		E	0.2				
11		FILLING - grey and brown, slightly gravelly sand filling with some clay, damp		E*	0.5				
	1.0	Bore discontinued at 1.0m - refusal on concrete obstruction		E	1.0				

RIG: Bobcat **DRILLER:** Gregor **LOGGED:** Mikhail **CASING:** Uncased
TYPE OF BORING: 100mm diameter solid flight auger with TC-bit to 1.0m
WATER OBSERVATIONS: No free groundwater observed
REMARKS: E = Environmental Sample; *Field Replicate FR4 collected from 0.5m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: RLO
Date: 30.5.08

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BOREHOLE LOG

CLIENT: Goodman Property Services (Aust) Pty Ltd
PROJECT: Preliminary Contamination Assessment
LOCATION: 17 O'Riordan Street, Alexandria

SURFACE LEVEL: 11.7 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: E3A
PROJECT No: 45586
DATE: 19 May 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.16	CONCRETE							
	0.65	FILLING - grey and brown, slightly gravelly sand filling with some clay, damp							
		Bore discontinued at 0.65m - refusal on concrete obstruction							

RIG: Bobcat **DRILLER:** Gregor **LOGGED:** Mikhail **CASING:** Uncased
TYPE OF BORING: 100mm diameter solid flight auger with TC-bit to 0.65m
WATER OBSERVATIONS: No free groundwater observed
REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: RW
Date: 30-5-08

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BOREHOLE LOG

CLIENT: Goodman Property Services (Aust) Pty Ltd
PROJECT: Preliminary Contamination Assessment
LOCATION: 17 O'Riordan Street, Alexandria

SURFACE LEVEL: 11.7 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: E3B
PROJECT No: 45586
DATE: 19 May 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
		CONCRETE - with 8mm diameter reinforcement		E	0.2				
	0.19	FILLING - brown and grey, slightly gravelly sand filling with some clay, damp		E*	0.5				
	1			E	1.0				
		- some brick rubble at 1.2m							
	1.3	FILLING - brown and grey sand filling, with some gravel and a trace of clay, damp		E	1.5				
	1.7	FILLING - dark grey and brown, slightly clayey sand filling with a trace of gravel, damp		E	2.0				
		- some clay from 2.2m		E	2.5				
	2.8	SAND - grey, medium grained sand with a trace of silt, damp		E	3.0				
	3.0	Bore discontinued at 3.0m - target strata							

RIG: Bobcat **DRILLER:** Gregor **LOGGED:** Mikhail **CASING:** Uncased
TYPE OF BORING: 100mm diameter solid flight auger with TC-bit to 3.0m
WATER OBSERVATIONS: No free groundwater observed
REMARKS: E = Environmental Sample; * Field replicate FR5 collected from 0.5m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: RW
Date: 30-5-08

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BOREHOLE LOG

CLIENT: Goodman Property Services (Aust) Pty Ltd
PROJECT: Preliminary Contamination Assessment
LOCATION: 17 O'Riordan Street, Alexandria

SURFACE LEVEL: 11.7 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: E4
PROJECT No: 45586
DATE: 19 May 08
SHEET 1 OF 1

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0.13	CONCRETE		E	0.2				
		FILLING - yellow brown and brown, sand filling with some gravel and a trace of silt, humid - grading to orange brown and brown at 0.6m		E	0.5				
				E	1.0				
	1.3	FILLING - orange brown and grey, slightly clayey, sand filling with a trace of gravel, damp		E	1.5				
	1.6	Bore discontinued at 1.6m - refusal on buried obstruction							

RIG: Bobcat **DRILLER:** Gregor **LOGGED:** Mikhail **CASING:** Uncased

TYPE OF BORING: 100mm diameter solid flight auger with TC-bit to 1.6m

WATER OBSERVATIONS: No free groundwater observed

REMARKS: E = Environmental Sample

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U,	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ≢ Water level

CHECKED
Initials: RW
Date: 30-5-08

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BOREHOLE LOG

CLIENT: Goodman Property Services (Aust) Pty Ltd
PROJECT: Preliminary Contamination Assessment
LOCATION: 17 O'Riordan Street, Alexandria

SURFACE LEVEL: 11.5 AHD
EASTING:
NORTHING:
DIP/AZIMUTH: 90°/--

BORE No: E5
PROJECT No: 45586
DATE: 19 May 08
SHEET 1 OF 1

Depth (m)	Description of Strata	Type	Depth	Water	Well Construction Details
0.14	CONCRETE - with 8mm diameter reinforcement	E	0.2		Flush Gatic Cover; Concrete plug; Sand backfill
	FILLING - orange brown and brown, sand filling with some gravel and a trace of silt, humid to damp	E*	0.5		Bentonite Pellet Plug
		E	1.0		
		E	1.5		
	- some brick rubble at 2.0m	E	2.0		Backfilled with gravel
2.6	- grading to damp to moist at 2.3m	E	2.5		
3.1	FILLING - orange brown and brown, slightly clayey, sand filling with a trace of gravel, damp to moist	E	3.0		Machine slotted PVC screen
	SAND - yellow brown and grey, medium grained sand with a trace of silt	E	3.5	▼	
4.5	- grading to yellow brown at 3.8m				End cap; Hole Collapse
	Bore discontinued at 4.5m - target depth				

RIG: Bobcat **DRILLER:** Gregor **LOGGED:** Mikhail **CASING:** Uncased

TYPE OF BORING: 100mm diameter solid flight auger with TC-bit to 4.5m

WATER OBSERVATIONS: Free groundwater observed at 3.6m

REMARKS: E = Environmental Sample; *Field replicate FR6 collected from 0.5m

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials: RW
Date: 30-5-08

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